MICROBIOLOGY

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Microbiology

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OBJECTIVES

Following training, the employee will be able to:

1. Define microbiology and microorganism.

2. List the four main areas of microbiology.

3. Discuss the major characteristics of bacteria and viruses.

4. Explain what endospores are and their importance to the SPD technician.

5. Discuss the four conditions necessary for disease transmission to take place.

6. Define vector and fomite and cite examples of each.

7. List the two criteria necessary for disease to develop.

8. Define nosocomial infection.

9. Explain the importance of hand washing and list the situations when hands should be washed.

10. Explain the concept of universal precautions and the blood borne pathogens standard.

11. Define disinfection and list the three levels of disinfection.

12. Define sterilization and explain the process of sterilization.

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MICROBIOLOGY AND INFECTION CONTROL

1. It is imperative that an SPD technician understand what microorganisms are so they can be effectively controlled, contained, and killed. SPD's objectives are to provide centralized supply support of the medical center's patient care programs, while assuring appropriate aseptic conditions, economy of operation, and consistency in processing, storing and distribution, all under strictly controlled conditions. In order to accomplish these objectives, SPD functions to control the number of microorganisms present on medical supplies, instruments, and equipment.

2. **MICROBIOLOGY**

a. Microorganisms have been around since the beginning of time. However, it was not until the late 1600's that they were seen by the human eye and acknowledged as an entity. Antonj van Leeuwenhoek, a Dutch linen draper, was able to observe different forms of bacteria through his invention, the microscope. It was not until the end of the nineteenth century that the work of Louis Pasteur led to the development of the science of microbiology. Joseph Lister, an English surgeon, expounded on Pasteur's experiments and was able to formulate principles of aseptic technique. His work involving aseptic technique led him to be known as the "Father of Antiseptic Surgery."

b. Microbiology is the branch of biology that studies microbes. Microbes are tiny microorganisms containing one cell. Some of these microorganisms are harmful, but many are not. Because the number and characteristics of microbes varies so much, the study of these microorganisms has been specialized over the years. These areas include, but are not limited to, bacteriology -- the study of bacteria, virology -- the study of viruses, protozoology -- the study of protozoa, and mycology -- the study of fungi.

3. **BACTERIA**

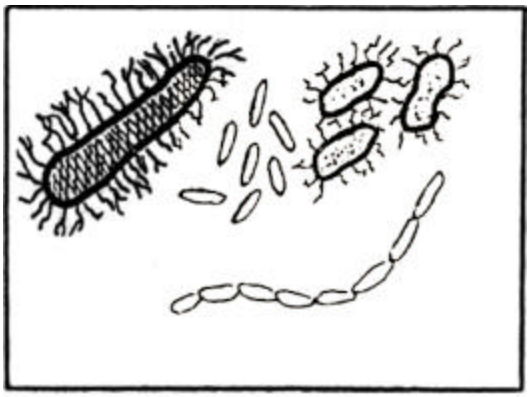
a. Bacteria are probably the most versatile of the microorganisms, being able to function in a variety of conditions. They are composed of only one cell and range between 0.4 and 2 micrometers in size. Although they lack a distinct nucleus and some don't contain a cell wall, most bacteria contain the systems and genetic material which are necessary for growth and reproduction. Locomotion is possible in some bacteria through the use of single-filament flagella. Oxygen also plays a significant role in the growth of bacteria. Anaerobes grow only in the absence of oxygen; oxygen is toxic to these microbes. Aerobic bacteria are those organisms that require oxygen for growth. Some bacteria, whether anaerobic or aerobic, can grow with varying levels of oxygen present. The shapes that bacteria can appear vary between the spherical cocci, rodlike bacilli, or spiral forms.

b. Bacteria may be useful or harmful, depending on where they are isolated. Bacteria that cause fermentation in the making of buttermilk, cheese, vinegar, and

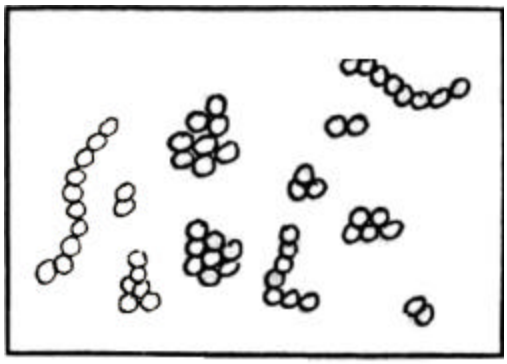
alcohol are useful. Some bacteria live in the digestive tract of humans and animals aiding in food digestion. E. Coli is an example of one of approximately 50 bacteria found in the colon. However, if E. Coli gains access to the urinary tract, infection may ensue. Useful bacteria are more numerous than harmful. Harmful bacteria will sour milk and make butter rancid. Bacteria may cause infections resulting in discomfort, severe illness, and even death. Some of the most commonly recognized diseases caused by bacteria include boils, sore throat, whooping cough, blood poisoning, diphtheria, gonorrhea, meningitis, and pneumonia.

4. **GRAM STAIN**

Bacteria are often classified by their Gram staining properties. The Gram stain was formulated early in the 1800's by Christian Gram as a means to identify organisms. Organisms, which are said to be Gram-positive, will stain blue; those that are Gram-negative will have a red stain.



Baccili



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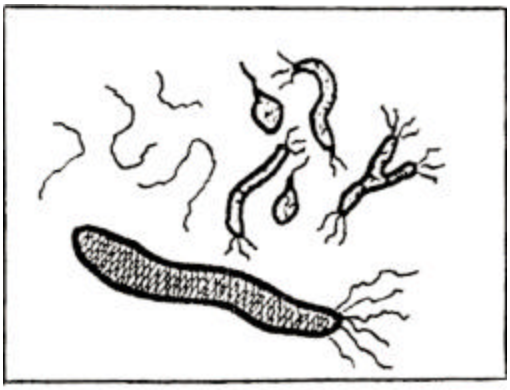


Spirilla

Gram Stain

5. **ENDOSPORES**

When conditions exist which are harmful to the cell, certain bacteria are able to protect themselves by forming endospores (spores). As the environment begins to change around the cell, a heat-resistant, nongrowing structure forms within the cell. This is the endospore. Its ability to survive exposure to chemicals and disinfectants, heat, freezing, and radiation is increased dramatically. When conditions return to those in which the cell can grow, the spore reverts to its viable state. The survivability of endospores is well-documented. Some spores can survive exposure to liquid nitrogen (-190 degrees C) for half a year. Spores were found in the pyramids of Egypt. After returning them to favorable environmental conditions, the spores were able to return to their viable state. As these examples clearly indicate, it is imperative that methods be devised and used to ensure endospores are killed in the decontamination and sterilizing cycles of SPD. Spores, being the most difficult microorganisms to kill, are used to challenge the sterilizer function to assure a kill rate is achieved. Spore-forming bacterial infections include anthrax, botulism, gas gangrene, and tetanus.

6. **VIRUSES**

Viruses are the smallest and most primitive of infectious agents. Research into viruses is still limited. There are many things we still need to know about viruses in order to understand how they produce disease. In fact, most cannot be seen with an ordinary microscope. They can range in size from 20-300 manometers. Viruses have the ability to reproduce rapidly. However, viruses are inactive outside of a host body and can only reproduce while in a living cell. A number of human diseases are caused by viruses, including chickenpox, measles, polio-myelitis, influenza, rabies, hepatitis B, and AIDS.

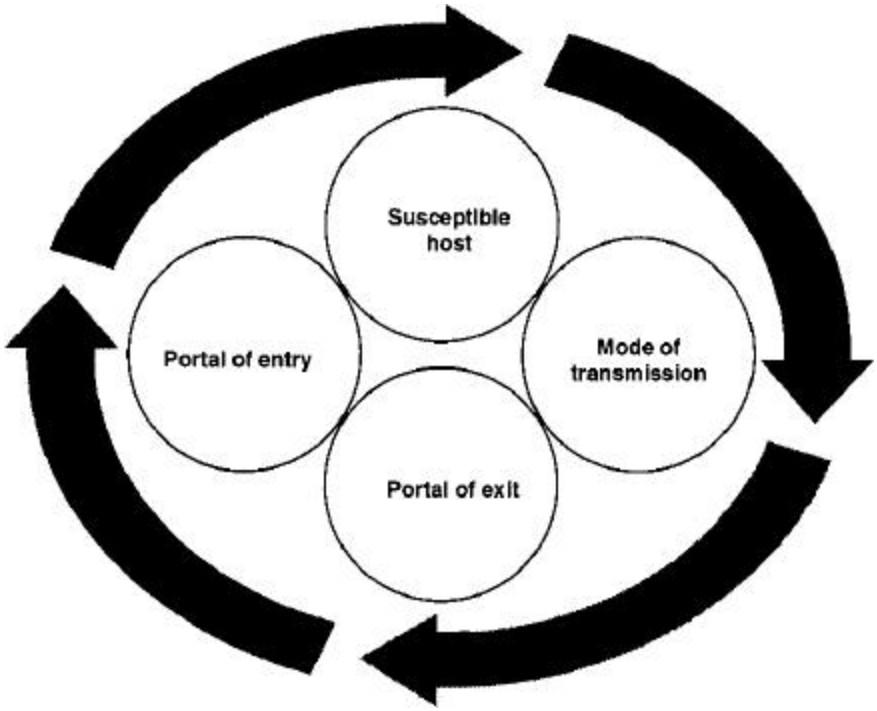
7. **PROTOZOA**

Protozoa are classified as parasites. A parasite is an organism that must live within or on other living organisms in order to survive. They draw nourishment from their host organism. Protozoa range in size from 1 micrometer to 50 millimeters or more. Being a self-contained unit, protozoa are considered to be the lowest form of animal life. Examples of diseases caused by protozoa are malaria and amebic dysentery.

8. **FUNGI**

Fungi may be the most familiar family of microorganisms. They appear in two major forms: molds and yeasts. Although there are numerous species of fungi (100,000), only a fraction of these (about 100) can be related to diseases in humans and animals. Fungi are larger than bacteria. They can be composed of a single cell, as small as 2 micrometers, or multicellular colonies which are visible to the naked eye. Fungal cells are composed of a nucleus, nuclear membrane, and a rigid cell wall and, in many ways, resemble cells of higher plants and animals. Unlike those of the plant kingdom, fungal

COMPONENTS OF THE INFECTIOUS DISEASE PROCESS (CHAIN OF INFECTION)



1. **Portal of exit of the agent.**
2. **Mode of transmission of the agent.**
3. **Portal of entry into host.**
4. **Susceptible host.**

cells are unable to produce their own food through photosynthesis. Lacking this ability requires them to live as parasites or saprophytes, drawing nutrients from other living or decaying organisms. Because of this, fungi are most commonly found in water, soil, and decaying organic matter. Molds can cause diseases, such as athlete's foot and ringworm. Yeasts can cause diseases of the skin, mouth, and genitals. Not all fungi are harmful. The antibiotic penicillin is a derivative of the fungi mold. Some fungi are also used in the production of foods, such as cheese.

9. **DISEASE TRANSMISSION**

It is the job of SPD to minimize or eliminate the possibility of any patient or employee acquiring an infection or disease from the use of any patient care equipment, instrument, or medical product by means of decontamination and sterilization. Disease transmission can only occur if four conditions exist: there is a portal of exit, pathway of transmission, portal of entry, and the new host is susceptible to infection. If any of these factors are not present, transmission of disease cannot take place. Therefore, one need only interrupt the flow of the disease transmission process at any point in order to prevent acquiring the pathogen. See illustration.

10. **PORTAL OF EXIT**

Pathogenic, or disease producing, microorganisms generally have specific departure paths from the host body. For many pathogens, this path runs either through the respiratory tract (mouth, nose), alimentary tract, or genitourinary tract (feces, urine). Pathogens can also exit the body in the blood, as is the case with HIV and hepatitis B and other blood borne pathogens.

11. **PATHWAY OF TRANSMISSION**

Pathogens are normally transmitted by either direct or indirect contact. Direct contact between persons is the most common mode of disease transmission. However, indirect transmission also occurs in the forms of airborne particles, vectors, and fomites. Airborne particles are cast off by persons when they sneeze, cough, laugh, or even during normal conversation. These particles can be carried for great distances and usually enter the noninfected host through the respiratory tract. Vectors are living organisms, such as mosquitoes, rats, and flies, that transport infectious organisms between hosts. For instance, typhoid fever is transferred by flies from the feces of patients to the food that is eaten by otherwise healthy recipients. Fomites are inanimate objects responsible for the spread of infection. Bedding, drinking cups, or patient care equipment could all be potential carriers of infection from one person to another in a hospital setting.

12. **PORTAL OF ENTRY**

Just as pathogenic microorganisms usually have specific portals of exit, they also invade the body through specific portals of entry. The most common portals of entry include the respiratory tract, alimentary tract, genitourinary system, and skin. Most pathogens can only produce disease if they enter the body through a specific avenue. For instance, the typhoid bacteria will only cause disease if ingested in the stomach. However, although the primary disease may not manifest itself when introduced into the body by an alternate entry point, a secondary infection may occur.

13. **SUSCEPTIBILITY OF THE HOST/PROBABILITY OF INFECTION**

a. Even when microorganisms are successful in entering a host body, a disease may not develop unless two criteria are met: the host is susceptible to the disease and the pathogens are present in sufficient numbers to cause the disease.

b. There are many factors which affect how susceptible a host is to the invasion of a pathogenic organism. The general health of the host is an important factor. Good nutrition, exercise, rest, and personal hygiene all help to fight off disease. Those who are more susceptible to infection are the very young and the very old. Also vulnerable are those whose immune systems are already compromised, such as persons with HIV, cancer, or who are taking immuro-suppressive medications.

c. If the host is not found to be susceptible to infection from the microbe, the organism will simply die. However, if the microbe found a suitable portal of entry, infection will not take place unless the microorganism is present in sufficient numbers to overcome the body's defense mechanisms. Only then will disease be produced in the host. Unbroken skin acts as a barrier to bacteria. In the stomach, acidic secretions destroy many microorganisms. In the blood, white blood cells attack and destroy bacteria. The lymphatic system is responsible for making lymphocytes that help the human body fight disease and produce antibodies.

14. **NOSOCOMIAL INFECTIONS AND CROSS-CONTAMINATION**

a. Nosocomial, or hospital acquired, infections are infections that a patient acquires while in the hospital. Although only a small percentage of patients entering hospitals develop nosocomial infections (approximately 3-5 percent), the additional expenses incurred in treating these patients amounts to more than one billion dollars each year (Center for Disease Control). SPD plays a significant role in preventing these infections due to the nature of the work that we do. In every instrument set that is decontaminated and sterilized, and every piece of patient care equipment that is disinfected and reissued, lies the possibility of a veteran developing complications due to cross-contamination. In order to eliminate this possibility, SPD must break the disease transmission cycle through the use of proper infection control procedures and good common sense.

b. At the very foundation of SPD lies several principles and procedures that have been developed to interrupt the transmission of infection and disease between patients and employees.

15. **HAND WASHING**

a. An important, but often overlooked, step in the battle against nosocomial infections and cross-contamination is simple hand washing. Hand washing is the single most important procedure for preventing nosocomial infections. The Center for Disease Control defines hand washing as a "vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water." After hands are washed, use a paper towel to turn off the water to prevent recontamination of the hands.

b. SPD technicians must be sure to wash their hands frequently and thoroughly to prevent cross-contamination and the spread of nosocomial infections. Hands should always be washed immediately if contaminated with blood or other body fluids and after gloves are removed. In addition, employees must wash their hands before going on duty, before and after meals, after using the bathroom, after handling soiled items, before entering the clean area or handling clean items, and before going off duty.

16. **UNIVERSAL PRECAUTIONS**

In the past, personnel exposures to individual cases of diseases and infections were controlled through the use of isolation techniques. These specified what type of personal protective equipment and aseptic techniques were necessary in different situations. Since then, the different types of isolation have been replaced by the concept of Universal Precautions, as recommended by the Centers for Disease Control (CDC). This means that all blood and body fluids are considered to be potentially infectious, which necessitates the utilization of personal protective clothing and equipment by the SPD technician. In 1990, OSHA also published the blood borne pathogen standard, which required employers to take the necessary steps to reduce the potential for exposure to pathogens occurring under normal working conditions. The goal is to prevent any blood or other infectious materials from reaching any employee's skin, eyes, mouth, or other mucous membranes which may serve as a portal of entry. In compliance with the blood borne pathogen standard, each SPD technician is offered the Hepatitis B vaccine series at no charge. If the vaccine is refused by the employees, they are required to sign a declination statement, which is kept in their health records. The employees can, at any time, change their minds and decide to accept the vaccination. The Hepatitis B vaccine is recommended for anyone who may, through the course of their duties, come into contact with blood or body fluid. It is strongly recommended that medical supply technicians receive the hepatitis B vaccine.

17. **DISINFECTION PRINCIPLES**

Many items used to deliver patient care cannot be sterilized. These items are rendered safe for use by subjecting them to a chemical disinfectant. Disinfection is the process by which some, but not all, pathogenic microorganisms are destroyed. Disinfectants are agents used on inanimate objects. Chemical agents used to kill microbes on living tissue, such as the hands, are called antiseptics. Disinfectants are commonly referred to in terms of their efficacy, i.e., high-, medium-, or low-level disinfectants. High-level disinfectants will kill most microorganisms, but not bacterial spores. Medium-level disinfectants are effective against many bacteria and viruses, but are ineffective against some and will not kill spores. Low-level disinfectants are effective only against some bacteria and viruses.

18. **STERILIZATION PRINCIPLES**

a. Any item that will penetrate a mucous membrane or skin must be subjected to a process that will eliminate all forms of microbial life on that item. That process is known as sterilization. Sterilization is a process that destroys all microorganisms, including endospores, that are present on an object. The term *sterile* is an absolute term; either an item is sterile or it is not. In SPD, sterilization is normally accomplished by utilizing one of two methods: saturated steam under pressure or ethylene oxide (EtO). Two other methods, dry heat and chemical sterilization, exist but are rarely used for terminal sterilization in VA.

b. In order to assist in the process of sterilization, it is important that the bioburden, or amount of microorganisms present, is reduced as much as possible. That is why each item must go through the process of decontamination before being sterilized. In addition to reducing the amount of bioburden on an object, the decontamination process will also remove any debris, which may lead to infection if left in or on a patient.

c. Sterilization is not an exact science. There is no known way to prove an item is sterile because as soon as the package is opened, it is subject to contamination by airborne microorganisms. What we do in SPD is provide the procedures and processes necessary to maintain a high probability that the item is sterile when it is issued. Evidence, in the form of chemical, biological, and mechanical indicators, is gathered daily to help assure this is so.

Microbiology Terms

Aerobes
Anaerobes
Antiseptic
Bacteria
Bacteriology
Bioburden
Blood borne Pathogen
CDC
Disinfectant
Disinfection
Endospore
Fomite
Fungi
Gram Stain
High-level Disinfectant
Low-level Disinfectant
Medium-level Disinfectant
Microbes
Microbiology
Mycology
Nosocomial Infection
Pathogen
Protozoology
Sterile
Sterilization
Vector
Virology
Virus
Universal Precautions

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MICROBIOLOGY

1. Microbiology is:

   a. the branch of biology that studies diseases in man.
   b. the study of how plants grow.
   c. the branch of biology that studies microbes.
   d. the branch of biology that studies small animals.

2. A microbe is a microorganism which:

   a. contains only one cell.
   b. causes infection and disease.
   c. contains one or more cells.
   d. contains one cell but no nucleus.
   e. contains one or more cells without nucleuses.

3. Bacteria may appear in three shapes. They are:

   a. rod-like bacilli, spiral, and cylindrical.
   b. circle, square, and line.
   c. spherical cocci, rod-like bacilli, and spiral.
   d. spherical cocci, rod-like bacilli, and straight.

4. The method developed in the 1800's used to identify bacteria is:

   a. the bacteria stain
   b. by name.
   c. the Gram stain.
   d. both b. and c.

5. An endospore (spore) is:

   a. a type of bacteria that can only reproduce in the presence of oxygen.
   b. the smallest type of bacteria.
   c. a protective, heat-resistant, non-growing form of bacteria.
   d. both a. and b.

6. Viruses are:

   a. the smallest of the infectious microorganisms.
   b. inactive outside of a host body.
   c. able to reproduce only while in a living cell.
   d. all the above.

7. Protozoa:

a. are the lowest form of animal life.
b. are the only disease producing viruses which affect man.
c. must live within or on other living organisms to survive.
d. both a. and c.

8. Disease transmission can only occur if:

a. there is a portal of exit, pathway of transmission, and portal of entry.
b. there is a portal of exit, pathway of transmission, portal of entry, and the host is susceptible to infection.

9. The most common mode of disease transmission is through:

a. sharing handkerchiefs.
b. coughing.
c. insects.
d. direct contact between persons.

10. A vector is:

a. an inanimate object that is responsible for the spread of infection.
b. a straight line drawn between two points.
c. a living organism that transports infectious organisms between parties.
d. an airborne particle cast off by a person when they sneeze, cough, laugh, or talk.

11. A fomite is:

a. an inanimate object that is responsible for the spread of infection.
b. a small insect which is responsible for the spread of rubella.
c. a living organism that transports infectious organisms between parties.
d. an airborne particle cast off by a person when they sneeze, cough, laugh, or talk.

12. Pathogenic microorganisms usually have specific portals of entry into and exits out of the body.

a. True
b. False

13. After entering the body, a disease may not develop unless:

a. the portal of exit is closed off.
b. the microorganism is present in sufficient numbers to cause the disease.
c. the person is susceptible to the disease.
d. both b. and c.

14. Susceptibility to infection is greatest in:

a. the old.
b. those whose systems are worn down with other infections.
c. the young.
d. all the above.

15. A nosocomial infection is:

a. an infection that occurs as a result of surgery.
b. an inexpensive infection that is normally contracted during a hospital stay.
c. preventable only by eating all your vegetables.
d. an infection that a patient contracted while in the hospital that he/she did not have before being admitted.

16. The single most important procedure for preventing nosocomial infections is:

a. doing your job right.
b. washing your hands.
c. don't go into the hospital.
d. don't touch anything.

17. Universal precautions refer to:

a. the concept that unsafe conditions can be found anywhere.
b. the concept that only blood should be considered potentially infectious.
c. isolation techniques used with specific cases of diseases and infections.
d. the concept that all blood and body fluids are handled as if they were infectious.

18. The goal of OSHA's blood borne pathogen standard is:

a. to prevent any contact with blood or other infectious materials under normal working conditions.
b. to prevent any blood or other infectious material from reaching any employee's skin, eyes, mouth, or other mucous membrane.
c. to have a present in the hospital.
d. to standardize dress attire in the medical center.

TRUE/FALSE

19. Bacteria absorb food from their environment directly through their cell wall.

20. Some forms of bacteria grow best where there is no free oxygen.

21. Viruses are found in one of three shapes: spiracle, rod-shaped, or spiral-shaped.

MATCH

22. ____ Minute, single cell organisms that grow in pairs, chains, or clusters and are generally found in one of three shapes.

23. ____ In general, they may be classified into one of three levels: high, medium, or low.

24. ____ The microorganism responsible for such diseases as chicken pox, measles, and AIDS.

A. bacteria

B. viruses

C. disinfectants